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FOURTEENTH BIENNIAL REPORT

OF THE

Discontinued
Bureau of Labor
and Industrial Statistics

PART IV

Boiler Inspection and
Insurance

STATE OF WISCONSIN
1909-1910

J. D. BECK, Commissioner

WM. H. PRICE, Deputy

RECEIVED

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Chicago School of Civics
and Philanthropy



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1910

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BOILER INSPECTION AND INSURANCE.

INTRODUCTORY.

Many inquiries are directed to the Bureau of Labor and Industrial Statistics under the erroneous supposition that this department has the authority to inspect boilers. In Wisconsin, according to the last factory inspectors' reports, there were 2,485 firms using steam power. The number of boilers in use was 5,103 and the horse power of the same was 478,941. This number does not include steam boilers used in threshing, nor small portable engines remote from railways. There is no state law requiring any inspection or examination except the power that is granted to city councils by Sec. 925—49, Stats. 1898, "to provide for the inspection and regulation of stationary steam engines and boilers." No city has taken advantage of this right and the boilers in this state remain uninspected unless insured by some casualty company. Sec. 4358 provides that "anyone having charge of any steamboat or railroad train for the conveyance of passengers, or any engineer or other person having charge of the boiler of such steamboat or locomotive of such railroad train or of any other apparatus for the generation of steam who shall from ignorance or gross neglect, or for the purpose of excelling any other steamboat or railroad train in speed, cause a collision or wreck of such steamboat or railroad train, or create or allow to be created such an undue quantity of steam as to burst or break the boiler or other apparatus in which it shall be generated, or any apparatus or machinery connected therewith by which collision, wreck or bursting or breaking of such boiler any person shall be killed, shall be deemed guilty of manslaughter in the third degree."

This pamphlet is issued for the purpose of showing the seriousness of the question of explosions, the means of protection offered by insurance companies, and by the inspection laws of other states.

CHAPTER I.

BOILER ACCIDENTS.

The public mind does not realize the tragic possibilities wrapped up in the thousands of boilers that are scattered throughout the state except when some particularly destructive and fatal explosion occurs. Thousands of lives are daily put in jeopardy by the failure of owners and users to appreciate the danger from this source.

The records of accidents show the dangerous nature of boiler explosions and the number of accidents is startling when the total is known. The increase in the size and pressure of boilers has been accompanied by the invention of various kinds of safety appliances and better methods of construction so that the danger of explosion is not so much from the new and improved ones as from the old ones which are still in use.

Boiler Explosions in Wisconsin.—A list of boiler explosions in Wisconsin since 1890 has been compiled in Table I from *The Locomotive* which is the Hartford Steam Boiler Inspection and Insurance Company's magazine. The list may not be as complete for the earlier years as for recent years owing to the poorer telegraph and news facilities during the early period.

The damage resulting directly from the explosions cannot be ascertained, owing to the lack of details regarding accidents, nor the damage resulting from the loss by fire which follows the boiler explosions and which in many instances causes a greater loss than the explosion itself. The property loss has been noted in Table I whenever the information was given.

TABLE I.—Accidents in Wisconsin from January 1, 1891–December 31, 1908.

Date.	Location.	Industry.	Killed.	Injured.	Damage.	
1891.						
Mch. 12	De Pere.....	Rank's saw-mill.....	2	3	\$3,000	
Mch. 16	Ellis Jc.....			4		
May 28	Oshkosh.....		2			
Dec. 19	Neillsville.....	Farland Bros.' saw-mill..	1	3		
1892.						
June 23	Stevens Point...	Joeek's saw-mill.....	4	1		
Nov. 21	Racine.....	Hardware shop.....		1		
Nov. 25	Milwaukee.....	Schroeder lbr. mill.....	3			
1893.						
Mch. 5	Boscobel.....				Several thousand	
May 21	Oshkosh.....	Steam yacht "Eva".....		2		
Sept. 5	Plymouth.....	Gardner's foundry.....		2		
Sept. 14	Columbus.....	Threshing engine.....	1	1		
Oct. 26	Ashland.....	Pulp mill.....	2	4		
Nov. 10	Garfield.....		1	2		
Nov. 20	Butternut.....	Wis. Cent. R. R. pump house.		2		
Nov. 29	New Coeln.....					\$1,000
Nov. 30	Milwaukee.....	National Distilling Co...				\$10,000
Dec. 2	Marinette.....					Small loss.
1894.						
Jan. 13	Appleton.....	Willy & Co. flour mill....	1		\$5,000	
Feb. 28	Plum City.....	Ohidester's saw mill.....		5		
Mch. 6	Rock Elm.....	Hammond Bros.' mill.....		3	Mill wrecked.	
Apr. 18	Boscobel.....	Evers's saw mill.....		1		
July 2	Milwaukee.....	Milwaukee mill furnish- ing Co.		1		
July 18	Menomonie.....				Bldg. wrecked.	
July 26	New Cassel.....	Young & Dyer's flour mill	1		Mill wrecked.	
Aug. 25	Lake Geneva.....	Steam yacht "Cyguet".....	1		\$12,000	
Sept. 24	Marion.....	Boiler in meat shop.....				
Oct. 24	Markesan.....	Peacock grain elevator.....		1		
Dec. 15	Appleton.....	Willy & Co. flour mill....	2	2		
1895.						
Feb. 7	Lancaster.....	Nathan & Sons' store.....		3		
Mch. 6	Menekaune.....	School boiler exploded....				
June 23	Milwaukee.....	Steamer "Christopher Columbus"	1	10		
July 25	Sheboygan.....	Engine used by contractor		2		
Oct. 27	Wausau.....	Portable wood sawing en- gine.			Roof blown off.	
Oct. 28	Milwaukee.....	Salisbury's elevator.....				
1896.						
Jan. 7	Melrose.....	Traction engine.....			Engine house de- molished. Mill destroyed. Two locomotives wrecked.	
Feb. 1	Pittsville.....	Saw-mill.....				
Apr. 2	Rich and Center.	Eastland Bros.' mill.....	2	2		
May 23	Wauzeka.....	Kickapoo Valley & North- ern R. R.	1			
1897.						
Oct. 15	Marinette.....	Threshing engine.....	2	3	Bldg. wrecked.	
Oct. 25	Wausau.....	Wausau Excelsior Co.....		1		
Dec. 15	Plymouth.....	Locomotive on C. & N. W. railway.....		1		
1898						
Jan. 14	Superior.....	Aug. Torke's grist mill....		1	3 locomotives wrecked. \$50,000 to \$75,000. Totally de- stroyed.	
Jan. 24	Madison.....	Locomotive in C. & N. W. Ry. round house.	3	2		
Feb. 1	Marinette.....	Mar. & Men. Paper Co.....	1	2		
Feb. 24	St. Croix Falls...	Wm. Ehrig's mill.....		2		
Apr. 28	Burnett County.	Bailey Bros. saw mill.....	1			

TABLE I.—*Accidents in Wisconsin from January 1, 1891—December 31, 1908—Continued.*

Date.	Location.	Industry.	Killed.	Injured.	Damage.
June 24	Manitowoc.....	Waterworks boiler.....			
Sept. 20	Waukesha.....	Gas & Electric Co. boiler.....			
Oct. 25	Green Bay.....	Reformatory.....			
1899.					
Jan. 15	Appleton.....	Willy Bros.' flour mill....	1	4	\$30,000.
Mch. 2	Waterville.....	Creamery boiler.....			
Mch. 3	Rib Lake.....	J. J. Kennedy's planing mill.....		1	Bldg. wrecked..
Apr. 15	Chippewa Falls..	Taylor & Creggs mill.....	2	3	
May 7	Oshkosh.....	Pa. ne Lumber Co. mill....	2	3	\$10,000.
May 23	Medford.....	Schlaiss Bros.' mill.....			
May 30	Sturgeon Bay....	Leatham & Smith shipyard.....			
June 25	Sheboygan.....	Steamer Georgia.....			Boat sank.
Aug. 22	Appleton.....	E. H. Wickert mill.....	4	7	\$20,000.
Nov. 9	Eken.....	C. & N. W. Ry. pump-house	1	1	
Nov. 13	Wausau.....	Mortensen Lumber Co.....		1	\$3,000.
Dec. 25	Racine.....	Racine college.....			
Nov. 23	Wausau.....	West Shore Wood Co.....		4	
1900.					
Ja. 1	Oshkosh.....	City Library.....			
Feb. 6	Iron River.....	O. H. Campbell's saw mill	1	2	
Feb. 9	Appleton.....	Riverside Fiber Co.....	1		
Feb. 19	Ft. Atkinso.....	Hoard's creamery.....	1		
July 10	Pittsville.....	Jos. Applebaker's mill....		2	Mill wrecked.
Oct. 23	Hartford.....			2	
Nov. 26	Grand Rapids...	Pioneer Wood Pulp mill..	2	2	
Dec. 11	Ashland.....	Pile driving engine.....	1		Pile driver wrecked.
1901.					
May 21	Lodi.....	Manderville Block.....			Boiler went through two floors.
May 28	Waukesha.....	Waukesha Stone Co.....			
July 8	Barker's Corners	Creamery.....			Roof blown off.
July 22	Cambridge.....	Blizman & Kerth, creamery.			
Oct. 29	Antigo.....	Jas. Gilles' saw mill.....		1	
1902.					
Jan. 22	Chippewa Falls..	Wis. Cen. freight engine..		2	
Feb. 17	Fond du Lac.....	Winnebago Furniture Co.			\$5,000.
Mar. 18	Wausau.....	Wheeler & Gavitt's mill..	3		
Apr. 10	Beloit.....	Blake Knitting Co.....			Bldg. badly damaged.
Aug. 22	Hurley.....	Jas. Davis wood sawing engine.		2	Machinery wrecked.
Sept. 13	Ashland.....	Conucopia Lumber Co.....		2	
Oct. 9	Waukesha.....	Threshing engine.....		1	
Oct. 13	Milwaukee.....	Boiler in Mathews Bldg..			
1903.					
Feb. 9	Plymouth.....	Chas. Helminger's foundry.	1	7	\$25,000
May 11	Chippewa Falls .	Boiler in saw mill.....			
May 28	Sparta.....	Shattuck Bros.' feed mill			\$1,500.
Oct. 1	Marinette.....	Pulp mill.....	1		
Oct. 2	Janesville.....	Threshing engine.....	1		
1904.					
Feb. 9	Johnsons Creek .	House boiler exploded....			
Apr. 25	Pound.....	Frank Hemmes' saw mill	1	2	
June 17	Milwaukee.....	Boiler was being tested ..		4	
Aug. 11	Hudson.....	Threshing engine.....		2	Machine wrecked
Aug. 15	Burlington.....	Threshing engine.....		2	

TABLE I.—Accidents in Wisconsin from January 1, 1891—December 31, 1908—Continued.

Date.	Location.	Industry.	Killed.	Injured.	Damages.
Aug. 30	Manitowoc.....	Threshing engine.....	1	1	\$300.
Aug. 30	Spooner.....	Wm. Garnor's saw mill...	1	1	
Oct. 17	Eau Claire.....	Threshing engine.....	1	2	
Nov. 9	Clinton.....	Engine used to run shredder.			
Nov. 15	Silver Springs...	Engine used to cook feed.			Building demolished.
Nov. 21	Beloit.....	Boiler in creamery.....			\$1,000.
Dec. 1	Racine.....	Mitchell & Lewis.....			Small loss.
1905.					
Jan. 18	Cudahy.....	Milw. Rubber Wks. Co....		1	
Jan. 26	Appleton.....	Sherman Hotel.....		1	
Feb. 13	Kenosha.....	Thos. B. Jeffrey & Co....		2	
Feb. 24	Antigo.....	Wunderlich's planing mill	1	1	It badly wrecked.
Apr. 22	Superior.....	New York Block.....			
Apr. 24	Medford.....	Peter Anderson's saw mill			
May 4	Lone Rock.....	W. B. Genge flour mill....			Bldg. wrecked.
May 30	Barron.....	Barron heating and stave mill.		2	
June 29	Marinette.....	Steam yacht "Benita"....	1		
Sept. 21	Campbellsport...	Grossman's cheese factory			Boiler wrecked.
Sept. 23	Green Bay.....	Green Bay Fiber Co.....			
Oct. 16	Milwaukee.....	National Distilling Co....			Loss small.
Nov. 24	Greenleaf.....	Wilhams Bros.' flour mill	1		
Nov. 27	Appleton.....	Ritger Hotel.....			
Dec. 11	Milwaukee.....	Residence of Jos. Bach...		1	
1906.					
Jan. 3	Marinette.....	Marinette Planing Co....			
Jan. 22	Chippewa Falls..	J. Lagermaier's saw mill.	7	5	\$1,500.
Feb. 2	Appleton.....	Heating boiler.....			Slight.
Feb. 8	Kimberly.....	Kimberly-Clark Co.....			
Mch. 9	Allentown.....	Heating boiler in store ..	1		
May 19	Lake Geneva.....	Selfridge greenhouse.....			Considerable loss
July 10	McMillan.....	Planing mill.....			Slight.
Aug. 18	Milwaukee.....	Milw. Coke & Gas Co.....			
Oct. 9	New Richmond..	Threshing engine.....	2	5	
Dec. 5	Rosendale.....	Traction engine.....			Engine blown to pieces.
1907.					
May 7	Columbus.....	Kurth Brewing Co.....	1		
June 5	Milwaukee.....	Milw. Coke & Gas Co.....		1	
June 11	Milwaukee.....	Milw. Coke & Gas Co.....		2	
Aug. 2	Milwaukee.....	Thomas Furnace Co.....			
Sept. 16	Eacine.....	Higgins' Spring & Axle Co			
Sept. 21	Milwaukee.....	National Packing Co.....			
Oct. 8	Milwaukee.....	Thomas Furnace Co.....			
Nov. 6	Waukesha.....	Metropolitan Church Asso	1		
1908.					
Jan. 31	Brussels.....	J. B. Lardenols' shop	1	1	
Feb. 28	Milwaukee.....	Zohrlaut Leather Co.....			
Mch. 7	Milwaukee.....	Penn. Supply & Coal Co....	1		
Mch. 17	Crandon.....	Geo. Kempf planing mill.	3	1	
Apr. 4	Marinette.....	Menomonee & Marinette Paper Co.	1	2	
May 12	Port Edwards...	Port Edwards Fiber Co...			
June 24	Oshkosh.....	Tugboat "Whitford".....			
Aug. 20	Park Falls.....	Behnke saw mill.....	1	3	
Sept. 27	Portage.....	C. M. & St. P. freight engine.	1	2	
Oct. 20	Milwaukee.....	Milw. Coke & Gas Co.....			
Oct. 20	Pond du Lac....	Eastern Wis. Railway & Light Co.			
Nov. 7	Superior.....	Wis. Cent. roundhouse. ...	5	6	

TABLE II.—*Total Accidents in Wisconsin from 1891 to 1908.*

Year.	Number explosions.	Number killed.	Number wounded.	Total.
1891	4	5	10	15
1892	3	7	2	9
1893	10	4	13	17
1894	11	5	13	18
1895	6	1	15	16
1896	4	3	2	5
1897	3	2	5	7
1898	8	5	7	12
1899	13	10	24	34
1900	8	6	8	14
1901	5	.....	1	1
1902	8	3	7	10
1903	5	3	7	10
1904	12	2	14	16
1905	15	3	7	10
1906	10	10	10	20
1907	8	2	3	5
1908	12	13	15	28
Total	145	84	163	247
Average of 18 years.....	8.05	4.66	9.05	13.71

Accidents in U. S.—The number of accidents for the whole United States and the adjacent parts of Canada and Mexico, which were collected for the *The Locomotive*, is still more striking. The statistics have been kept since Oct., 1867. Last year the number of explosions passed the 10,000 mark. The number killed reached 10,884 persons and the more or less seriously injured, 15,634 persons. The total number killed and injured recorded is 26,518.

The most serious explosion in the history of the United States occurred in 1865 and therefore is not included in this summary. The *Sultana*, a Mississippi river boat, left Vicksburg crowded with Union soldiers. A few miles from Memphis her boiler exploded; many were killed outright, some were thrown into the river, and the boat took fire. In all 1,238 men and officers lost their lives in this disaster.

Table III shows the total accidents by years for the U. S. and adjacent parts of Canada and Mexico.

TABLE III.—*Summary of Boiler Explosions from October 1, 1867, to January 1, 1909.*From *The Locomotive*, Jan., 1909.

Year.	Number of boiler explosions.	Number of persons killed.	Number of persons injured.	Total of killed and injured.
1867*	81	48	59	100
1868	101	226	185	411
1869	96	147	268	415
1870	109	213	272	485
1871	80	383	225	608
1872	98	232	235	467
1873	92	130	215	345
1874	96	175	160	335
1875	102	134	195	329
1876	75	147	145	292
1877	83	157	201	358
1878	97	178	216	394
1879	122	206	213	421
1880	170	259	555	814
1881	159	251	313	564
1882	172	271	359	630
1883	184	263	412	675
1884	152	254	251	505
1885	155	220	278	498
1886	125	254	314	563
1887	198	264	388	652
1888	246	331	505	836
1889	190	304	433	737
1890	226	244	351	595
1891	257	263	371	634
1892	269	298	442	740
1893	318	327	385	712
1894	362	331	472	803
1895	355	374	519	838
1896	346	382	529	911
1897	369	398	528	926
1898	383	324	577	901
1899	383	298	456	754
1900	373	268	520	788
1901	423	312	646	958
1902	391	304	529	833
1903	383	293	522	815
1904	391	220	394	614
1905	450	383	585	968
1906	431	235	467	702
1907	471	300	420	720
1908	470	281	531	812
Totals	10,051	10,884	15,634	26,518
†Average of 41 years	244.3	264.1	380.	644.3

* Last three months of year.

† 1867 omitted.

From the data given, it appears that for the whole period of over forty-one years, the average number of persons killed per explosion, was 1.083, while the average number injured per explosion, was 1.555; the average number of persons that were either killed or injured per explosion being 2.638.

Severity of Accidents.—The average number of persons killed per explosion has been decreasing in recent years as is shown in Table IV.

TABLE IV.—*Comparison by Ten-Year Periods.*

From *The Locomotive*, January, 1909.

Ten year period.	Total number of explosions.	Total number of persons killed.	Total number of persons injured.	Persons killed per explosion.	Persons injured per explosion.	Persons injured per person killed.
1868 to 1877.....	941	1,944	2,101	2.07	2.23	1.08
1878 to 1887.....	1,604	2,422	3,299	1.51	2.06	1.36
1888 to 1897.....	2,926	3,252	4,535	1.11	1.55	1.39
1898 to 1907.....	4,079	2,937	5,116	0.72	1.25	1.74

If the number of persons killed is taken as an indication of the seriousness of the explosions, this ten year grouping shows that accidents are growing less serious. This change for the better can be explained in two ways. In the first place the design, construction and operation of boilers have improved greatly during this period of forty years and the smaller number of deaths may be due to the improvements and inventions made during the period.

The Locomotive however explains the decrease by saying that "the progressive diminution in seriousness is in a considerable measure illusory, being due mainly to the vast improvement that the forty years have brought in our facilities for obtaining information concerning explosions." The telegraph service was less complete at that time than it is now and the Hartford Company's agents, by whom the information was collected, were few in number so that in the earlier period the less serious accidents escaped their attention. Accidents of less importance are reported now and the seriousness of accidents would seem to diminish even if there were no diminution in reality.

Accidents by Months.—Table V shows the number of accidents by months for the forty year period.

TABLE V.—*Classification of Boiler Explosions by Months since 1868.*From *The Locomotive*, January 1909.

Month.	TEN YEAR PERIOD.				Forty years. 1868 to 1907.	Percentage of Explosions per Month During forty- year period.
	1868 to 1877.	1878 to 1887.	1888 to 1897.	1898 to 1907.		
January	98	181	288	425	992	10.39
February	87	141	269	347	844	8.84
March	68	129	224	337	748	7.83
April	83	102	180	294	659	6.90
May	67	117	205	260	649	6.79
June	65	126	177	263	631	6.61
July	56	124	211	305	696	7.29
August	73	138	276	339	826	8.65
September	86	131	246	359	822	8.61
October	87	129	301	377	894	9.36
November	81	143	275	389	888	9.30
December	90	149	274	394	901	9.43
Totals	941	1,604	2,926	4,079	9,550	100.00

This table shows that there is no decided variation in the number of accidents by months. As might be expected there is a slight increase during the winter months of October, November, December and January, which can be explained by the greater use of heating boilers. April, May and June show the smallest per cent. February, a month almost as cold as January, shows a marked decrease in the average per cent and is only slightly greater than the per cent for August, one of our hottest months. We conclude therefore that there is no fixed rule in reference to the frequency of accidents except that a few more occur in the colder months than in the warmer ones.

Accidents in England.—Table VI is taken from the report of the secretary of the British Board of Trade upon the working of the Boiler Explosions acts of 1882 and 1890. It includes the accidents in Great Britain and Ireland. The English law gives the Board of Trade power to investigate accidents but makes no provision for inspection. The investigation shows that 23 out of the 54 boilers which exploded in 1906, were not inspected.

TABLE VI.—*Total Number of Explosions under Boiler Acts of 1882 and 1890.*

Year.	Number of boiler ex- plosions.	Number of persons killed.	Number of persons injured.	Total killed and injured.
1882-83	45	35	38	68
1883-84	41	18	63	80
1884-85	43	40	63	103
1885-86	57	33	79	112
1886-87	37	24	44	68
1887-88	61	31	52	83
1888-89	67	33	79	112
1889-90	77	21	76	97
1890-91	72	32	61	93
1891-92	88	23	82	105
1892-93	72	20	37	57
1893-94	104	24	54	78
1894-95	114	43	85	123
1895-96	79	25	43	73
1896-97	80	27	75	102
1897-98	84	37	46	83
1898-99	68	36	67	103
1899-1900	59	24	65	89
1900-01	72	33	80	93
1901-02	68	30	55	85
1902-03	69	23	67	89
1903-04	60	19	45	64
1904-05	57	14	40	54
1905-06	54	25	21	46
1906-07	77	28	65	93
Total	1,705	697	1,480	2,157
Average of 25 years	68.2	27.9	59.4	86.3

This table shows an increase in the number of accidents up to 1895 and since that time there has been an actual decrease in number and seriousness. The last few reports show the fewest number of accidents and the smallest number of killed and injured during the period in which inspections of boilers and investigations of accidents have been made.

The number of persons killed per explosion is 0.41, the number injured is 0.85 and the total killed and injured per explosion is only 1.26 persons. The class of accidents reported seems to be about the same as recorded by *The Locomotive*, so that relatively there is great difference between the seriousness of accidents in England and in the United States. The number of persons killed per explosion in this country is 1.083 for forty-one years and 0.96 for the twenty-five year period from 1883 to 1906 inclusive.

This shows that the death rate per explosion is over twice

as great for the United States as it is for England. The injuries per explosion show the same discrepancy in favor of England.

The statute under which the English accidents are investigated requires that all accidents be reported to the Board of Trade within twenty-four hours of their occurrence. Each accident is carefully looked up and the responsibility and blame fixed. If there was no inspection or if the owner disregarded the recommendations of an inspector, the heavy costs of the inquiry are assessed upon him. The law is not compulsory but merely tends to have a corrective influence.

Accidents in Germany.—Table VII shows the number of accidents and the seriousness resulting therefrom for a period of thirty years. This list of accidents was collected for *The Locomotive* from the reports made to the police authorities and is as complete as it was possible to secure.

The number of persons killed per explosion is 0.64 as compared with 0.41 in England for a period of twenty-five years and 0.96 in the United States for the same period. The more favorable showing of foreign countries is in a large part due to the greater care exercised by foreign officials in enforcing the laws of inspection. Railroad accidents are very much less in foreign countries than they are in the United States for the same reason.

TABLE VII.—*Total Number of Explosions in Germany.*Taken from *The Locomotive*, April, 1909.

Year.	Number of explosions.	Personal Injuries.			
		Instantly killed.	Seriously injured.	Slightly injured.	Total of killed and injured.
1877	20	21	14	23	58
1878	18	7	4	9	20
1879	18	36	10	32	78
1880	20	10	5	14	29
1881	11	8	18	21	47
1882	11	19	14	15	48
1883	14	23	8	24	55
1884	14	12	11	22	45
1885	13	11	2	9	22
1886	16	10	5	8	23
1887*	14				
1888	1	4	3	4	11
1889	16	6	5	17	28
1890	16	9	1	11	21
1891	10		3	7	10
1892	18	12	11	18	41
1893	10	6	5	10	21
1894	35	12	9	13	34
1895	23	20	23	31	74
1896	21	10	2	13	25
1897	21	17	3	19	39
1898	18	3	7	21	31
1899	14	13	11	11	35
1900	13	6	1	17	24
1901	17	10	3	14	27
1902	17	7	7	10	24
1903	10	6		5	11
1904	15	5	5	8	18
1905	9	4	2	3	9
1906	15	5		3	8
1907	16	7	4	5	16
Totals	498†	319	196	417	932
Average for 31 years	16.1	10.3	6.3	13.5	30.1

* "We have no full statistics for 1887. The 14 explosions recorded include 37 individual boilers. The terrible explosions at Friedenshutte, illustrated in our issue for June, 1888, and in which 22 boilers blew up simultaneously, occurred in that year. By that explosion three employees were instantly killed, nine were injured so badly that they died within a few days, and thirty others were injured more or less severely, but not fatally."

† Column totals 484.

CHAPTER II.

BOILER INSURANCE.

That there is a need of some means of protecting lives and property from the danger of boiler explosions is shown in Chapter I. The number of deaths and accidents shows that there is a field for enterprising men to establish insurance companies and do business in this line.

Origin of Boiler Insurance.—The idea of boiler insurance originated in Hartford, about the year 1857. An association in England had been organized before this time with the object of protecting owners of boilers from loss by means of inspection. Periodical inspections were made, and a certificate of safety was issued if the boiler was in good condition, or the boiler was condemned if found in bad condition. This association, however, did not insure the owners against loss in case of accidents, but merely sought to prevent explosions.

In 1866 the Hartford Steam Boiler Inspection & Insurance Company was established and incorporated under the laws of Connecticut. This company undertook to insure boilers exclusively and success has followed its efforts until today it is the largest boiler insurance company in the world. A substantial indemnity in case of loss was guaranteed by the Hartford Company, which was an innovation in the business and was not offered by any company in England. Other companies have followed the Hartford Company in the field and to-day there are thirteen companies engaged in the boiler insurance field. All the other companies, however, have made their boiler insurance a side line and also deal in accident, health, liability, plate glass, burglary and other kinds of business.

Object of Insurance Companies.—The object of boiler insurance is not so much insurance as the prevention of explosions. Each company has a force of inspectors who do nothing else but make inspections of boilers that are insured and boilers which owners wish to insure. Before a boiler is ac-

cepted as a risk by a company it must be thoroughly inspected and overhauled. If any dangerous defects are found by the company's representative, they must be repaired before the boiler will be insured. Most companies advertise that they make four inspections annually. Some make one complete internal and external inspection and three other inspections; others make two internal inspections and two external inspections. The inspection preliminary to the acceptance of a boiler for insurance is very minute and complete. The expert of the company, usually known as an inspector, has a long list of measurements and questions which must be answered. He examines the boiler internally for rust, corrosion, or scale; and externally in regard to safety appliances and manner of operation.

After the examination has been made the inspector makes his recommendations and report to the chief inspector. From the data obtained and from the history of the age, construction and type of the boiler, the chief inspector figures out a safe working pressure for the boiler. A copy of the report is subsequently forwarded to the owner.

It sometimes happens that a thorough inspection reveals some dangerous defects which were not suspected by the owner. In such a case the inspector advises certain repairs and alterations before the risk will be accepted. If the owner fails to comply with the requirements, no further business can be done with him. Some boilers are found in such bad shape that the inspector must refuse to recommend them as risks under any circumstances.

When a boiler has been insured by a company, it is inspected frequently in order that it may be kept in good running order. The company requires that the owner shall have the boiler ready for inspection at reasonable times, and that ample facilities shall be provided for the examination. Any defects found must be repaired within a reasonable time or the policy can be suspended. If the defects are dangerous and can not be repaired the policy may be canceled.

Insurance Policies.—The policies give the assured the option of deciding which kind of loss shall be paid first. The policy covers any loss or damage (1) to the boiler or other property of the assured, (2) to any damage to other property for which the assured may be liable, and (3) for any liability

for bodily injuries of the assured or anyone to whom he may be liable. The amount of damages for which the company is liable is limited to the amount of the policy and its financial responsibility for the death of one person is fixed. As in fire insurance, policies usually run for three years.

Premiums.—The premium rate for insurance does not vary with the risk as in other lines of the insurance business. By means of regular inspection all the boilers are kept in good condition, or the policy is canceled, so that there is no more extra risk or hazard in one boiler than in another. The rate depends upon the location or accessibility of the boilers, and the skill and qualifications of the men employed to do the work. Otherwise the rate varies for the number of boilers and the character of business in which the boilers are used. As the largest item of expense to a company is the amount expended for inspection, the location of the boiler is a matter of first consideration. In Montana the state inspector's fee is only five dollars in incorporated cities, whereas it is ten dollars in other sections of the state. The ability of a good engineer is recognized when it comes to a matter of insurance and the competence and skill of the operator is reflected in the premium rate. Two or more insurable boilers are taken at a less rate than one because the inspection expense decreases as the number increases. One isolated boiler would require almost as much time as two or more boilers that are easy of access and the inspection expense per boiler is lessened. Special rates are quoted for heating boilers as the danger of explosion is less than for power boilers.

Amount of Policy.—The usual amount of a policy for one boiler is \$5,000 and the amount is increased for each additional boiler. The premium rate varies in different companies from \$30 for three years for a \$5,000 policy to \$50 for the same kind of a risk. As the general understanding is that an owner pays for the inspection more than for the monetary protection, the service of inspection probably varies as does the rate. Where the damage is likely to be greater than \$5,000, the policy for one boiler is also greater. For instance a boiler may be located in a factory near valuable working material or a large number of men may be engaged near a boiler. The amount of damage to material or injury to workmen in such a case would undoubtedly be greater than where the boiler is located in a separate shed or building. Consequently an owner

is allowed to insure himself against loss by a larger policy than \$5,000 without any proportionate increase of the premium rate as the inspection expense remains fixed and a correspondingly larger part of the premium is available for the payment of damages.

Per Cent of Losses to Premiums.—The part of the premium that is paid out for losses is very small when compared with other kinds of insurance. The largest boiler insurance company in the world estimates that its losses comprise less than ten per cent of the premiums received and ninety per cent is left to pay the cost of inspection and other running expenses. Other companies are not so fortunate in this respect. One company in 1906 paid out 43.4 per cent of its premiums for losses but in 1907 this per cent for the same company was only 1.7. For another large company the average payment of losses for 1906 and 1907 was 20.3 per cent.

Other Work Done by Insurance Companies.—In the event of an accident, the companies do not end their responsibility with the payment of the premium but their experts, who have had experience in the clearing away of the ruins, offer their services. In case of a disagreement in the settlement of damages, the company has its appraiser, the owner selects an appraiser, and these two select a third and impartial person who acts as umpire. The policy binds an owner to accept this method of settlement and abide by the decision.

In addition to the departments for carrying on the regular business, insurance companies have special departments for the benefit of their customers. A department of construction and drafting is maintained, under the charge of specialists, which will furnish plans and advice for the construction of new plants and the improvement of old ones. A department of chemistry will analyze waters to determine their fitness for use in boilers and suggest means of remedy for injurious water. One of the greatest evils is caused by impurities in water, and the resulting corrosion and incrustation of boilers. Companies also publish magazines and pamphlets from time to time, which contain valuable articles on the construction, installation and maintenance of power plants.

Business in Wisconsin.—Table VIII shows the premiums received and the losses paid by each company during the last five years.

TABLE VIII.—Boiler Insurance Business done in Wisconsin from January 1, 1904, to December 31, 1908, Compiled from Insurance Commissioner's Report.

COMPANY.	1904.		1905.		1906.		1907.		1908.	
	Premiums received.	Losses paid.	Premiums received.	Losses paid.	Premiums received.	Losses paid.	Premiums received.	Losses paid.	Premiums received.	Losses paid.
Empire State Surety Co.	\$305 66	.....	\$423 25	.....	\$1,597 33	.....	\$30 00	.....	\$104 26	\$0 25
Casualty Co. of America.	12,342 37	\$155 21	11,886 52	\$55 48	14,088 73	\$500 25	1,733 85	.....	12,280 23	103 93
Employers' Liability Ins. Co.	.....	.....	.....	.....	.....	.....	410 02	.....	.....	.....
Fidelity & Casualty Co.	.....	.....	.....	.....	.....	.....	15,233 52	\$519 32	.....	.....
Hartford Steam Boiler Insp. and Ins. Co.	31,253 54	1,804 63	37,493 76	679 44	34,873 42	945 98	37,838 78	488 73	23,064 65	3,875 30
Maryland Casualty Co.	2,188 30	112 30	4,516 30	.....	3,161 87	332 41	5,076 43	.....	6,140 60	.....
Ocean Accident & Guarantee Corp	94 45	.....	189 24	1,674 53	716 50	.....	886 18	.....	2,236 67	.....
Travelers' Indemnity Co.	.....	.....	.....	.....	.....	.....	180 00	.....	1,810 45	.....
U. S. Casualty Co.	729 20	.....	940 25	.....	385 00	2,860 53	486 24	.....	781 20	.....
Philadelphia Casualty Co.	522 76	.....	863 46	.....	990 11	.....	564 25	.....	.....	.....
Total	\$47,436 28	\$2,072 14	\$56,132 78	\$2,439 45	\$55,822 96	\$4,699 17	\$62,499 37	\$1,008 05	\$46,486 06	\$1,053 48

The amount of business done in Wisconsin by boiler insurance companies for the last five years is given in Table IX.

TABLE IX.—*Boiler Insurance Business in Wisconsin from January 1, 1904, to December 31, 1908.*

Year.	Premiums received.	Losses paid.	Per cent losses are of premiums.
1904.....	\$47,436 28	\$2,072 14	.043
1905.....	56,132 78	2,439 45	.0434
1906.....	55,822 96	4,699 17	.084
1907.....	62,499 37	1,008 05	.015
1908.....	46,498 06	4,053 48	.087
Total.....	\$268,389 47	\$14,272 29	.0531

CHAPTER III.

STATE BOILER INSPECTION.

The second means of preventing boiler explosions and accidents is by state regulation. Seventeen states and the District of Columbia have passed laws making certain requirements of owners and operators of stationary steam boilers and engines which will insure safety to life and protection to property in those states. Other states¹ have passed laws requiring the examination of steamboat engineers and inspection of steamboat boilers. The United States government has a permanent force of 87 steam vessel inspectors under the direction of the Inspector General, who annually makes inspections of all boats and vessels, propelled by steam within the jurisdiction of the United States government. Other states have mine inspectors whose duty it is to safeguard the lives of mine employees, as experience has shown that many of most disastrous accidents have occurred in mines. Two states² require periodic inspections of locomotive boilers. Such regulation, however, has been undertaken in other states as railroad companies, of their own initiative, have realized the economy of regular inspections, and have a permanent corps of skilled inspectors. One state³ requires all railroad companies to examine locomotive engineers as to their fitness and ability.

Systems of Inspection and Examination.—The methods of regulating stationary steam boilers and engines and their operation differ in the several states. These methods can be classified into five general classes as follows:

1. State Inspection of Engines and Boilers.
2. State Examination of Engineers.
3. State Inspection and Examination.

¹ Indiana, Maine, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Washington.

² New York and Massachusetts.

³ Alabama.

4. Inspection by competent boilermakers, and reports filed with state officer.

5. Safety appliances required.

State Inspection.¹—Two states² have state steam boiler inspectors, without any provision for state examination of engineers. Colorado has one boiler inspector for the entire state but he can appoint deputies whenever needed in the various judicial districts. In Connecticut there is an inspector for each congressional district.

The duties of these inspectors are specified by law and are about the same in all states requiring inspection. They must make annual inspections which are very thorough. The maximum pressure that each boiler can carry is determined by hydrostatic pressure and a penalty is fixed for any violation of this limit. A certificate of inspection is given if the results of the examination are satisfactory, but in case a boiler is found to be unsafe the inspector either orders repairs or condemns the boiler altogether.

Examination of Engineers.—Examination of engineers but with no provision for inspection is required in three¹ states and in the District of Columbia. This method places the burden of inspection upon the engineers and presupposes that protection will be secured by having competent engineers or operators. The owner is made liable to a fine or imprisonment if he hires an unlicensed operator and an unlicensed operator can be punished if he is found in charge of a boiler or engine.

In Nevada the Board of County Commissioners for each county holds examinations and grants licenses. Only one year's experience around steam boilers is necessary in order to take an examination. Licenses granted in one county are good throughout the state.

The Missouri law applies only to cities having a population of over 20,000 and makes it a misdemeanor for any person to run an engine within such cities who has not been examined by some incorporated association of qualified engineers and secured a certificate of competency from said association. A law similar to the Missouri law is in effect in the province of Ontario, Canada.

¹ These laws are taken from the 22d Annual Report of the U. S. Department of Labor and includes all laws passed to the end of the year 1907.

² Colorado and Connecticut.

¹ Missouri, Nevada, Ohio.

The Ohio law provides for one chief examiner and for eight district examiners. One year's experience as firemen or oiler is necessary before an applicant can take this examination. An unlicensed operator is liable to a fine if found in charge of an engine.

Inspection and Examination.—Five states¹ have a system of inspection of boilers and examinations thereby combining the advantages of protection of life and property from accidents resulting from the operation of steam engines and boilers. The inspectors usually hold the examinations and have the power to grant and revoke licenses.

The Maryland laws apply only to the city of Baltimore and provides for two inspectors, whose duty it is to make annual internal inspections, to make hydrostatic tests and grant certificates of inspection to owners of boilers and engines. Quarterly inspections are also made, and a certificate can be revoked pending repairs, or a boiler condemned.

A Board of Examiners for the city of Baltimore is appointed by the governor, which examines all applicants twenty-one years of age or over and either grants or refuses "certificates of proficiency" as the case may be. It also inspects the engineers at work, and can at any time revoke a certificate.

In Massachusetts a "Board of Boiler Rules" is appointed by the governor, which consists of five members whose duty it is to formulate the rules for the regulation of steam boilers and engines. The chief boiler inspector is the chairman of said board and the other members must be selected so as to represent the following interests: Boiler using interests; boiler manufacturing interests; boiler insuring interests; and boiler operating interests. The rules must be approved by the governor before being printed and distributed.

The inspection corps is under the Department of District Police. The state is divided into districts, and each inspector must make annual inspection. A boiler cannot be used before a certificate of inspection is granted.

Licenses are granted to engineers and firemen upon examination held by the district inspectors, and are graded according to the mark of the applicant. There are three grades of engineers' licenses based upon the horse power of the engine and the steam pressure carried by the boiler. Firemen's licenses are of

¹ Maryland, Massachusetts, Minnesota, Montana, Pennsylvania.

three grades based likewise on the horse power and steam pressure. An applicant, however, can be examined on his ability to run some special engine upon the request of the owner.

In Minnesota the governor appoints an inspector in each of the fifty-three senatorial districts except where there is more than one district within a county and then he makes an appointment for the county. These inspectors are to meet annually in St. Paul to make rules for the regulation of steam boilers and when the rules are approved by the governor they have the force of law.

Every owner, lessee or other person having charge of steam boilers is compelled to have an annual inspection made by the state boiler inspector. The inspectors have power to grant or refuse certificates of inspection and also to revoke them at any time.

All engineers must be licensed by the state inspector in order to take charge of a boiler. The licenses are of four classes as follows: Chief engineers, requiring five years' experience; first class, requiring three years' experience; second class, requiring one year's experience; and a special license granted to applicants who cannot take charge of boilers of more than thirty horse power.

Montana has a state boiler inspector and two assistant inspectors, who must have had five years' experience as engineers and have no connection with any boiler manufacturing company. Annual inspections are required and additional inspections may be made at any time. All operators of engines or boilers must hold a state license, which is granted by the chief inspector or his assistants. The licenses are of three classes based on the experience of the applicant. Firemen must hold a third class engineer's license in order to take charge of an engine. Traction engineers must also obtain a license.

In Pennsylvania examinations are held under the direction of boiler inspectors of the various cities. The law provides for inspectors in cities of the first, second and third classes although the act does not affect any city of the third class until the council of said city shall by ordinance provide for the creation of the office of boiler inspector therein. To take an examination two years' experience is required.

Other Inspections.—Three states¹ require the owner, agent,

¹ Indiana, New York, Pennsylvania.

manager or lessee of any boiler to have an inspection made at least once in six months by a competent boilermaker or steam engineer approved by the state factory inspector or the department of inspection. A certificate of such inspection must be filed with the factory inspection department or be shown to the factory inspector when required. This section of the Pennsylvania law applies to cities and towns that do not have a local inspector.

Safety Appliances.—Ten states¹ require that all boilers and steam engines be equipped with certain safety appliances and fix a penalty for a failure to comply with these requirements. Three of these states, Iowa, Maine and Michigan have no other means of regulation than certain specified equipment for all boilers. The Iowa law requires steam gauges, water gauges and safety valves, but makes no provision for inspection. The Maine law prohibits the manufacture, sale or use of any steam boiler unless provided with a fusible safety plug. The Michigan law makes it the duty of the state factory inspectors to inspect all boilers for a low water alarm, which will sound an alarm when the water has reached a dangerous point. The requirements of the other states are merely auxiliary means of protection in addition to the safeguarding of life and property by means of the inspection of boilers or the examination of engineers; and the means of their enforcement is through the boiler or factory inspectors. After inspection the safety valves are loaded up to the maximum pressure as determined by test, and a penalty is fixed for any tampering with them.

Boilers to be Inspected.—The kinds and classes of boilers and engines that are to be inspected or to be exempt from inspection are usually defined by law. The question of inspection is based upon the pressure carried by the boiler or horse power of the engine, the kind of boiler and previous inspection by other inspectors.

The amount of pressure to be carried by a boiler before inspection is deemed necessary varies greatly in different states. In Massachusetts boilers carrying more than fifteen pounds pressure per square inch come under the jurisdiction of the boiler inspection department. In Maine, safety appliances are not re-

¹ Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, Montana, New York, Ohio, Pennsylvania.

quired on boilers which do not have a pressure of fifty pounds per square inch. Engines that are to be inspected are determined by the horsepower. In Maryland the limit for exemption is three horsepower; in Indiana engines under ten horse power are exempt; and in Ohio an engine must be of thirty horsepower before the engineer is required to have a certificate.

The necessity for inspection depends upon the kind of boiler or engine and the uses made of them. Locomotive boilers are exempt from the boiler inspection laws in all states except that in Massachusetts and New York their regulation is placed under the jurisdiction of the Railroad Commission. Boilers used exclusively for heating purposes in private residences and apartments are exempt. Likewise boilers used for steam heating where the water returns to the boiler without the use of any kind of pump are excepted. Traction engines are excluded in Montana, and in Massachusetts all boilers used for agricultural or horticultural purposes are excepted. Motor road vehicles are free from inspection in Massachusetts; and in Montana all boilers on wheels.

Boilers which have been previously inspected are exempt from state inspection. Steamboat boilers which come under the jurisdiction of the United States Steamboat Inspection Service are excepted in all states, some of which have special provisions for such boats as are not looked after by the government inspectors. The other boilers and engines, which are not subject to state inspection are those insured by insurance companies.

Inspections by Insurance Companies.—The confidence and trust in the reliability of boiler insurance companies and in the efficiency of their inspections is shown in the boiler inspection laws of the various states. A summary of the sections of the laws regarding insurance company inspections will show the light in which the states regard the insurance companies.

In Colorado the law does not exempt any boilers from inspection, but an owner, who intends to insure his boiler may have the state inspection made at the same time as the insurance inspection by giving ten days' notice to the state inspector.

In Connecticut insured boilers are exempt. A certificate of inspection may be granted by an insurance company in lieu of a state inspector's certificate, provided a policy is issued covering damage or loss arising from explosion.

Certificates of inspection are accepted by the inspection department of Indiana, as proof of the safety of a boiler.

In Maryland every insurance company must have a resident inspector, who must examine all boilers submitted for insurance. The owner must file his certificate of inspection with the state inspector and the company is charged one dollar for each and every boiler so inspected and insured, which is paid to the state inspector with such certificate.

The Massachusetts law requires the inspectors of insurance companies to hold certificates of competency and to take the examination for engineers. Insurance inspectors must make reports on all inspections to the Department of District Police and immediate reports on all boilers condemned.

In Minnesota all boilers insured and inspected by insurance companies and certified to be safe are exempt from inspection by the state.

Cleveland, Ohio, has a special boiler inspector for all boilers not inspected by insurance companies.

In Pennsylvania a certificate of inspection from an inspector of an insurance company, if filed with the inspection department, fulfills the requirements of the law.

Fees for Inspection and Examination.—All states except Connecticut attempt to defray by fees either part or all of the expenses of their inspection departments. The list of fees charged are given in Table X.

TABLE X.—*Inspection and License Fees.*

	Inspection fee.	License fee.	Renewal of license.
Cleveland, O.....	Fixed by city council...	.....	.....
Colorado.....	Five dollars.....	.....	.....
Connecticut.....	None.....	.....	.....
District of Columbia.....	.....	Three dollars.....	.....
Maryland.....	.....	Three dollars.....	\$1 50
Massachusetts.....	Internal, \$5; External, \$2.....	One dollar.....	1 00
Minnesota.....	Three dollars and \$2 for every connected boiler	One dollar.....	1 00
	{ Ten dollars.....	First class, \$7.50; second	1 00
Montana.....	Five dollars for each connected boiler and for boilers in cities.	class, \$5; third class, \$3.	
Nevada.....	.....	Five dollars.....	.....
Ohio.....	.....	Two dollars.....	2 00
Pennsylvania (cities of 1st, 2nd and 3rd class).....	.....	Three dollars.....	1 00

How the Laws Work.—The Indiana law must be very effective if the accidents are always as few as they were in 1907. Only one boiler explosion occurred, with no resulting fatalities, and only a slight injury to the engineer. The number of boilers in Indiana as given in the 1908 factory report is 4,904 of which number 1,441 were insured and inspected by insurance companies. The others were inspected by boilermakers approved by the factory inspector.

The boiler inspector's report of Montana for 1908 shows that not a single boiler explosion occurred in Montana during the previous year, except that one accident resulting from the collapse of a tube, caused the death of an engineer. The office is more than self-sustaining as the surplus of receipts over expenses was \$7,614.05.

In Pennsylvania 11,033 inspected boilers were reported to the state inspectors in 1907 and two boiler explosions are reported. In both cases the boilers had been inspected and reported in good condition. Evidence indicated that in both instances the water in the boilers had been allowed to run down and the accidents followed when water was injected. Inspections will not prevent accidents if the men in charge fail to do their duty.

The Boiler Inspector's report for Philadelphia for 1907 shows that no serious accidents occurred during the year. The receipts of the department were more than the expenditures. The inspector recommends that the city inspect all boilers and engines in the city, whether they are inspected and insured by insurance companies or not, as the competition for business is so keen that he is somewhat in doubt as to the condition of boilers under the care of the various insurance companies.

The New York factory inspector states that regulation has produced good results in operation. A large proportion of inspections are made by inspectors of casualty companies and their certificates have been accepted in all cases except one.

The dangers of explosions of locomotive boilers and other steam apparatus is shown by the report of the New York Public Service Commission. During the year of 1908 nine employees were killed and twenty-eight were injured by accidents due to steam explosions on locomotives. Of this number, however, eight of those killed and twelve of the injured were hurt in explosions resulting from low water in the boilers and not from defects. The locomotive boiler inspector appointed

by the Commission requires complete and detailed information regarding the size, equipment and history of all boilers in order to determine the working pressure and factor of safety for each boiler.

The Massachusetts boiler inspection force consists of a chief inspector, and nineteen assistants. For the year 1908 one explosion is reported in which the night watchman was killed and the factory was demolished. The Massachusetts department is the largest in the United States and was established as the result of some very severe and disastrous explosions which occurred in the state. The Board of Boiler Rules issues each year the rules and requirements with which all boiler owners must comply.

CHAPTER IV.

BOILER INSPECTION IN FOREIGN COUNTRIES.

England has no regulation requiring boiler inspection. Inspection, as generally in this country, is secured, not from public servants, but from boiler insurance companies. However, there is a stronger motive to insure, and thus to secure inspection, than in the United States, on account of the promptness and thoroughness of official investigations of accidents, and the heavy costs of investigation which are incurred in case of negligence. The Boiler Explosions Acts of 1882 and 1890, provide for an immediate inquiry by the Board of Trade into every accident, notice of which must be given, within twenty-four hours of its occurrence, by the owner or user or person acting for him, stating the name of the premises or works, postal address, day and hour of explosion, number killed and injured, description of boiler, purpose for which used, particulars of failure, working pressure, by whom last inspected, and by whom insured.

In the chief industrial countries, on the continent of Europe, periodical inspection is compulsory, and is usually provided through the agency of associations for the inspection of boilers.

Italy requires that every new or rebuilt boiler must be inspected before it can be used; every boiler must be tested once in four years, and every engine must be in charge of a duly qualified person. Regulation as to the construction of boilers is provided for, as well as certain specified safety appliances.

In Belgium all boilers must be inspected once a year. The chief institution existing for the purpose is the Association *Pour la Surveillance des Chaudières à Vapeur*, which transacts no insurance, being wholly an inspecting and advisory bureau. Inasmuch as the certificate of any engineer is acceptable, the business of inspection is not confined exclusively to responsible associations and engineers, according to the statement of Mr. R. S. Hale who made inquiries several years ago.*

* See bibliographic note below, page 244.

In France and Germany there are also numerous associations which similarly inspect and advise, without insuring, their certificates being legal equivalents of those of state inspectors. The Associations are organized on a mutual basis and are local in character.

The German regulations are very minute and will repay further examination:

The Imperial "*Gewerbeordnung*," 1869-'73, authorized certain general official regulations concerning the installation of steam boilers (*Allgemeine polizeiliche Bestimmungen über die Anlegung von Dampfkesseln*), which were amplified by the Bundesrath in 1890. Regulation in further detail, and enforcement, were left to the several states constituting the empire. The Prussian Law of 1872, as amplified by the decree of the Minister of Trade and Industry, 1890, may be taken as a good example:

The owner of a steam boiler plant, or his agents in the conduct of the business, as well as those charged with the care of the boilers, are required to see that the conditions of the license and the general rules of safety are observed, and that no unsafe boiler is used. Violation of the above involves a fine of not more than M.600 (about \$150 in United States money) or imprisonment of not more than three months. Every owner is obliged to procure, periodically, an official inspection by an expert possessing the requisite authority, and to bear the cost of the inspection. Boilers connected with governmental industries, such as the railroads, navy, etc., are inspected under the supervision of the officials in charge. Boilers connected with private undertakings are inspected by the publicly appointed engineers of boiler inspection associations. Associations of boiler owners which acquire distinction for regular and careful supervision of boilers may secure for their members an exemption from official inspection from the Minister of Trade and Industry. In this case the associations in question conduct their own inspections through their engineers, who follow rules given them by the minister. This arrangement is revocable at any time, and notices of the granting and annulling of such privileges must be published locally. In exceptional circumstances, a like concession may also be granted to individual boiler owners and to private railways. A regular external inspection takes place every two years in the case of stationary boilers, and annually in the case of locomotives and marine boilers. The

regular internal inspection occurs every four years, triennially in the case of locomotives, and biennially in the case of ships' boilers. The hydraulic test is required at least every 8th year, and every 6th year if not stationary.¹

¹ On boiler inspection in foreign countries consult:

Journal of Association of Engineering Societies, Phila.,—**European Boiler Practice**, by R. S. Hale, vol. 18, No. 4, p. 243. (April, 1897.)

Kempe's Engineers' Year Book, p. 294. London, (1901).

Hütte: Des Ingenieurs Taschenbuch. Herausgegeben vom Akademischen Verein Hütte, Zwanzigste Auflage, Berlin, (1908), Abteilung II, S. 129ff.

Zeitschrift des Vereines deutscher Ingenieure, Aug. 7, 1897, Jan. 28, 1905.

CHAPTER V.

METHODS OF BOILER INSPECTION.

There are three methods of inspection as follows:

1. Hydrostatic test.
2. External Inspection.
3. Internal Inspection.

Hydrostatic Test.—The hydrostatic test is accomplished by filling the boiler with cold water and by means of a pump applying a pressure to the boiler which is from one-third to one-half greater than the usual working pressure. If the boiler shows no signs of distress or leakage when subjected to the hydrostatic test, it may be considered reasonably safe. This method is usually applied to a new boiler or one that has undergone extensive repairs. It is better than the hammer test because the pressure is applied uniformly over all parts whereas a hammer might miss a weak spot. The hydrostatic test is not injurious to a boiler if it is made by an experienced engineer.

External Inspection.—External inspections are made when the boiler is under ordinary working pressure and takes into consideration the skill of the attendant, the pressure, the amount of water in the boiler, the safety valve, the water gauges and other details. These inspections are usually made without notifying the owner and if the operator is negligent or the owner is disregarding the inspector's instructions they can be found out.

Internal Inspection.—Internal inspections are the usual kind that are made by all inspectors. It is necessary for the inspector to go into the boiler through the man hole and test every part of the boiler for weak spots. He looks for deposits of sediment, scale on the tubes or plates, corrosion, fractures, leakage, seams, cracks and grooving of plates or heads. The internal inspection is followed by a complete external examination, and any weaknesses or defects of a boiler must surely be detected by a skillful and competent inspector.

Inspection is very effective in preventing and reducing the number of accidents. The Manchester Steam Users' Association of Manchester, England makes the claim that in the entire half century covering the period of its operations not a single life was lost or accident occurred from a cause which its inspectors could have foreseen. The reports of state boiler inspectors show that they are doing effective work.

Causes of Explosions.—The following table given by Mr. B. H. Thwaite in a lecture before the Yorkshire College Textile Society, printed in *The Locomotive*, shows the causes of 1079 boiler explosions

TABLE XI.—*Causes of 1079 Explosions.*

Cause.	Number.
External Corrosion	153
Over heating	133
Over pressure	118
Weakness of flue	106
Fracture	90
Internal Corrosion	73
General Deterioration	58
Defective Stays	54
Malconstruction	51
Grooving	31
Deposit	27
Weak man hole	23
Bad material	11
Absence of safety valve	7
Cause not ascertained	156
	<hr/> 1,079

Defects Discovered by Inspection.—The inspections made by state and insurance inspectors show that they have discovered just such defects as are given as the causes of many accidents. An illustration of the number and kind of defects found by inspectors is given in Table XII, which is the report of the Hartford Steam Boiler Inspection and Insurance Company.

TABLE XII.—*Summary, by Defects, for the Year 1908.*

Nature of defects.	Whole number.	Dangerous.
Cases of deposit of sediment.....	18,879	1,242
Cases of incrustation and scale.....	37,924	1,193
Cases of internal grooving.....	2,649	249
Cases of internal corrosion.....	13,053	555
Cases of external corrosion.....	9,400	698
Defective braces and stays.....	1,991	503
Settings defective.....	5,341	642
Furnaces out of shape.....	6,961	380
Fractured plates.....	3,119	482
Burned plates.....	4,605	440
Laminated plates.....	666	44
Cases of defective riveting.....	3,385	713
Defective heads.....	1,565	223
Leakage around tubes.....	10,929	2,103
Cases of defective tubes.....	8,026	2,136
Tubes too light.....	1,636	432
Leakage at joints.....	4,845	392
Water-gages defective.....	2,411	585
Blow-off defective.....	3,818	1,125
Cases of deficiency of water.....	391	147
Safety-valves overloaded.....	1,216	379
Safety-valves defective.....	1,068	359
Pressure gages defective.....	7,120	531
Without pressure gages.....	322	322
Unclassified defects.....	7	3
Total.....	151,350	15,878

Dangerous Defects.—The Hartford company made 317,537 inspections during 1908, of which 124,990 were internal inspections. The number of dangerous defects found was 15,878 as is shown in the preceding table and 572 boilers were condemned as being dangerous and unfit for use. The Massachusetts inspectors made 3,698 inspections during the same year, of which 2,996 were complete internal inspections. They found 14,066 defects in all and 5,925 were considered dangerous. The number of boilers ordered to be repaired was 3,055 and 48 were condemned.

The Hartford Company inspectors considered only 10.4 per cent of the defects dangerous while the Massachusetts inspectors classed 42.1 per cent as dangerous. The Maryland Casualty Company reported 16.6 per cent of defects as dangerous while the Montana inspector reported 70.4 per cent dangerous.

If the standard of inspection is the same for both classes of inspectors, this discrepancy would indicate that the insurance companies do not receive applications from the owners of inferior and worn out boilers. Hence the boilers which are really dangerous are not covered by insurance and the real need of state inspection is revealed.

CONCLUSION.

The alarming increase in the number of accidents and the consequent loss of life and destruction of property ought to arouse our legislative bodies to immediate action. They should pass good and effective laws to minimize the damage and injury resulting from these accidents. If the owner's loss of property or the danger to his life were the only considerations, no action would be necessary, as he would be the only one to suffer from his neglect. The employee, however, should not suffer through the carelessness of the employer. The state should consider the welfare of those who are compelled to labor and live in close proximity to dangerous boilers and engines.

At the present time employers fail to insure and inspect their boilers either through neglect or penury. Neglect is due to the carelessness of the owner or his failure to realize the necessity of inspection. This class of men usually accept the recommendations of state inspectors and do all in their power to prevent future accidents when they appreciate the danger. For the other class, who are miserly and penurious, a compulsory law is necessary. They cut down expenses by hiring a man who can shovel coal on the fire and turn water into the boiler but who knows nothing of the construction and proper maintenance of the engine. There are many small factories and laundries in the state at the present time where there is no regular attendant to look after the engine. A striking instance of the owner's neglect is the explosion of the boiler in the Winnebago Furniture Company's plant at Fond du Lac on Apr. 27, 1908. The report shows that the boiler never was inspected regularly, and the man in charge at the time never had had any experience in handling boilers. The property loss was estimated at from \$75,000 to \$80,000 for the factory, and \$3,500 to \$4,000 for the surrounding buildings.

It sometimes happens that a secondhand boiler is sold, of which the purchaser knows nothing of the age and history. It may be a boiler that has been condemned and sold to a second-

hand dealer, who fixes it up with a coat of paint and resells it to the unsuspecting and honest purchaser. The Montana law requires that any second-hand boiler sold within the state or shipped from another state must be inspected before it can be used. A fine of \$100 to \$500 is fixed for any violation of this law.

The laws of many of the progressive states make some provision for inspection of boilers or the safeguarding of lives from the danger of an explosion; the United States government has realized the need of protection of passengers on all steamboats and makes regular inspections of them; our great railroad companies make regular inspections of all their engines. The state of Wisconsin has done nothing in the way of inspection and many accidents occur every year, killing her citizens and destroying thousands of dollars worth of property without any such action on the part of the state as might avert and prevent their occurrence.

Every state should pass proper legislation designating authority to supervise the inspection of boilers, and the right to require: first, that the men in charge possess reasonable and safe qualifications; second, that the equipment include all the best safety appliances to be had; third, that regular internal inspections be made to discover defects caused by rust and corrosion and external inspections frequently enough to insure the fulfillment of the inspector's orders and to see that the operator knows his business; and fourth that the boilers be subjected to a periodical hydraulic test at the expense of the owner to determine a safe working pressure.

The question of expense should be a secondary consideration, protection to lives should be the first. Many of the inspection departments of other states are self sustaining and some pay to the state a considerable amount over and above their cost.

APPENDIX I.

COMPANIES AUTHORIZED TO TRANSACT STEAM
BOILER INSURANCE IN WISCONSIN FOR 1909.

(From report of Insurance Commission, May 1909.)

COMPANIES AND GENERAL AGENTS.

1. Empire State Surety Co., New York. Aug Rebhan, Gen. Agt., Mitchell Bldg., Milwaukee, Wis.
2. Aetna Accident and Liability, Hartford, Connecticut. J. S. Rome, Secretary, 650 Main St., Hartford, Conn.
3. Casualty Co. of America, New York. Aug. Rebhan Co., General Agents, Mitchell Bldg., Milwaukee.
4. Employers Liability Assurance Corporation (Ltd.), London, England. Loyal Durand, Wis. Gen. Agt., 83 Michigan St., Milwaukee.
5. Fidelity and Casualty Co., New York. Frank E. Delaney, Wis. Manager, Wells Bldg., Milwaukee.
6. Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn. Henry M. Lemon, Gen. Agt., 169 Jackson St., Chicago.
7. London Guarantee and Accident Co. (Ltd.), London, England. R. H. Norris, Wis. Gen. Agt., 371 Broadway, Milwaukee.
8. Maryland Casualty Co., Baltimore, Md. Roger L. Merrill, General Agt., 39-41 Mack Blk., Milwaukee.
9. Ocean Accident and Guarantee Corporation (Ltd.), London, England. J. E. Eldred, Gen. Agt., 10 Mitchell Bldg., Milwaukee.
10. Travelers' Indemnity Company, Hartford, Conn. Jno. L. Way, Secretary, 700 Main St.
11. United States Casualty Co., New York. D. G. Luckett, Secretary and General Manager, 141 Broadway. No general agent in Wisconsin.

APPENDIX II.

TWO RECENT BOILER EXPLOSIONS.

This Bureau has been at pains to investigate all serious boiler explosions within the state. The results of two recent inquiries are here presented. One of these was the explosion at the Winnebago Furniture Company's plant, Fond du Lac, and the other was at the Pabst Brewery in Milwaukee. The facts in each case, as nearly as they could be ascertained by inquiry in all possible quarters, were as follows:

I. FOND DU LAC EXPLOSION

The Fond du Lac explosion occurred about 4 a. m., the 27th of April, 1909. The only person injured was the watchman, who was slightly bruised and cut about the head and face and on the left hip. The property damage was estimated at \$75,000 to \$80,000 for the warehouse and contents, besides \$3,500 to \$4,000 for windows, poles and wires, and other adjacent property.

The boiler was an ordinary horizontal boiler about forty-eight inches in diameter, with twenty-four 2-inch flues, estimated to be from twenty-five to thirty-five years old. This boiler was literally torn to pieces. Parts were found scattered from three hundred to five hundred feet apart. The upper portion of the dome was found directly east of the courthouse, some five hundred feet away, having passed over the building. In descending it sheared off a fourteen inch telegraph pole and passed through the sidewalk into the ground. Another piece, evidently the rear end of the shell, with half of the head still attached, weighing about three hundred and fifty pounds was found directly south of the factory building about two hundred feet away, having passed either through or over the factory. Several other parts, such as flues, pipes and fittings were found scattered about in

various places, all tending to indicate the tremendous force of the explosion. It was impossible to find any part that might be positively said to be defective. All breaks appear to have been caused, not from defects in the metal, but rather by purely physical force. The manner in which the boiler was torn to pieces strongly indicates that cold water was turned into a red hot boiler; in fact this is generally attributed as the cause of the accident, although no definite information could be had that would prove this.

The boiler had originally been used in the power plant of a saw-mill and was transferred from there to a planing mill for the same use. From the planing mill it was brought to the furniture factory, but was not used thereafter for some time. About twenty years ago it was installed in the place where the explosion occurred, and has been used ever since as a heating boiler.

No insurance was carried upon this boiler as it was not deemed necessary. The boiler was not regularly inspected,—in fact no recent inspection had been made, excepting rarely by the plant engineer. No information as to the last responsible inspection was obtainable.

The manager of the plant made the statement that the boiler had been overhauled the previous summer, but the superintendent said that no repairs had been made, with his knowledge, during the past three years.

The only man near the boiler, at the time of the explosion, was the watchman in charge, who had been in this position only ten days, and had never had any experience in the handling of boilers of any kind. He is about sixty years of age, and had previously been employed by a street railway as a common laborer. For a number of years he had been in the employ of the Union Lime Co., at a small place named Hamilton, on the Wisconsin Central, about 12 miles from Fond du Lac, as foreman of a lime kiln.

The boiler house was an entire brick building, with a sheet iron roof. The factory building had brick walls with wooden trusses and roof. It was used for storage, and as a paint and finishing shop. (The factory proper of this plant stands about four hundred feet west of this building.) Portions of the building were found scattered about within a radius of four hundred feet. One ten inch joist, supposedly from the roof, was

carried up over the courthouse, falling end downward penetrating the roof of this building. The building seemed to have been shattered and the floor swept clean as though by a charge of dynamite. Portions of the wall were still standing, although shattered and crumbling. The manner in which portions of the buildings were blown in various directions and the evidence of the police officer showing that the flames were bursting from various portions of the building through crevices, all tend to show the great force of the explosion. Windows on Main street, five hundred and six hundred feet away were blown in; every window in the west side of the courthouse, and one steel shutter were blown in. There was no one from whom anything authoritative could be learned regarding the immediate cause of the explosion.

II. EXPLOSION AT THE PABST BREWERY

The explosion at the Pabst Brewery happened at about 4:30 a. m., November 1, 1909, and resulted in the destruction of considerable property, severe injury to one fireman on duty, and the death of the other. The firemen employed by this company are intelligent, sober, experienced, and reliable men. The chief engineer is about fifty years of age, and has had twenty-seven years of experience, ten years with the Pabst company. His assistant has had about twenty years of experience.

The boiler-house was a one story brick building about forty feet high above the basement. There was no stairway leading to the basement, which would have proved a good means of escape had there been time to use it. There were three doorways on the first floor, and one in the basement. There were eight boilers in the house, two of which were new, not having been fired. The other six were connected to the main steam pipe, forming a battery of two thousand four hundred horse power, each being a four hundred horse power boiler. The boilers were in a row, extending from east to west, and were numbered from one to eight in the same way. The first three exploded and the fourth was badly damaged so that it could not be repaired. Probably boiler No. 1 exploded first.

The damage to property amounted to nearly \$200,000.00 and was covered by insurance to about \$50,000.00. The boiler-house was completely wrecked and a great deal of damage was done

